GOOD PRACTICE GUIDE 293

# External insulation systems for walls of dwellings




- New build and refurbishment
- High-rise and low-rise residential
- Description of systems available
- Advice on selecting a system
- Impact on overall construction costs
- Critical detailing
- Durability and maintenance
- Built examples

GOOD PRACTICE GUIDE 293

ENERGY EFFICIENCY

BEST PRACTICE PROGRAMME

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**This Guide is based on material drafted by Gale & Snowden Architects and Peter Warm under contract to BRECSU for the Energy Efficiency Best Practice programme, in consultation with an expert EWI panel (Chris Buntain, Rodger Canning, Max Childs, Mervyn Kirk, Tim Stimson, Gary Taylor), INCA and INCA members**

# 1 INTRODUCTION AND DEFINITIONS

## INTRODUCTION

There are many different types of external insulation (EI) system for walls to choose from, which vary in quality and in their application. The choice of an appropriate system can be a daunting task for the first-time specifier.

Many homes, flats and tower blocks are being refurbished, sometimes only 20 or 30 years after construction. EI is often the most logical solution to achieve a range of improvements to the thermal performance and external façade of the building, especially for high-rise buildings. In some cases, it is the only practical method of achieving significant thermal upgrading.

EI is the most appropriate option when considering a renovation strategy of remedial works to combat long-term problems such as internal damp, water ingress and air infiltration leading to heat loss. It is best suited to use in a comprehensive rehabilitation scheme, including window and door replacement and the installation of new heating and ventilation systems.

New build is also an area where EI can increase energy efficiency and lead to economic benefits.

This Good Practice Guide provides general information on EI for architects, specifiers and builders who are new to the concept. It is concerned with both the renovation and new build of residential dwellings and includes a number of built examples.

The information contained in this Guide was compiled through a combination of desk research, site visits and industry consultation.

## DEFINITIONS

EI in its generic form is a composite system consisting of three key components:

- insulant – providing the thermal insulation of the system
- fixings or framework – providing a means of securely fixing the system to the substrate
- finish – a protective layer providing weather protection and a finish to the system, often including accessories that offer further protection and connection to elements of the building (such as windows and doors).

### Insulants

A variety of insulant products are used and these can be broken down into the following categories:

- mineral fibre – quilt or rigid slab
- closed cell foam – rigid panel, eg polyisocyanurate, urethane or phenolic
- expanded pentane blown polystyrene – rigid panel
- others – plant based (eg cork, cellulose, woodfibre, reed matting, hemp), or cellular glass.

### Fixings

A variety of fixings are used:

- mechanical fixing – metal or timber batten/rail system or framework and mechanical anchors or dowels
- chemical fixing – various adhesives
- mechanical and chemical fixing – a combination of the above fixings, eg chemical anchors.

### Finishes

There are two generic finishes:

- wet render – polymer and fibre-reinforced cementitious renders, polymeric coatings, insulating renders and cementitious renders
- dry cladding – rigid boards, panels and tiling in a variety of materials.

### SUMMARY

- EI is often the best option for upgrading the thermal performance of existing buildings, and should be considered in refurbishment strategies.
- EI can simplify construction and achieve environmentally significant thermal performance in new build projects.
- Large amounts of insulation can be used with EI, while easily avoiding thermal bridging. The building's structure will be protected and internal thermal mass can be achieved to moderate internal temperature fluctuations.

# 2 SELECTING EXTERNAL INSULATION SYSTEMS

### EXTERNAL INSULATION FOR THE REFURBISHMENT OF DWELLINGS

Thermal improvements are more cost-effective when part of a package of remedial and refurbishment works. For properties with walls that have a high U-value, wall insulation should be considered when replacing windows and adding loft insulation to avoid exacerbating condensation and mould problems in other parts of the dwelling. Wall insulation can be applied in the following ways:

- cavity fill insulation
- internal lining insulation
- external insulation (EI).


*Figure 1 The University of East London's Design and Engineering Campus, by Edward Cullinan Architects*

EI is appropriate for refurbishment projects where:

- the external walls are poorly insulated
- the external walls are deteriorating or insufficiently weather-tight, leading to damp, draughts and heat loss
- wall cavities are bridged or blocked, limiting the possibility for cavity fill insulation
- a drab and old-fashioned external appearance requires updating as part of a rehabilitation scheme in high-rise or system-built housing
- the use of internal lining insulation would be too disruptive, would alter critical internal dimensions or make room sizes too small.

### Other factors to consider

- The application of EI will involve alterations to various details of the building such as at eaves, windows, doors and where services puncture the external envelope.
- The planning authority should be consulted for all EI refurbishment projects. EI may not be appropriate where its application may alter the appearance of a sensitive or historic building.

### EI FOR HIGH-RISE DWELLINGS

Various types of EI are commonly used on high-rise dwellings to:

- increase energy efficiency
- protect the fabric of the building
- improve the appearance of the building
- improve comfort levels for the occupants.

| Insulation method | Upgraded external appearance | Potential for thermal improvement | Occupation during installation | Structural protection | Installation cost comparison |
|---|---|---|---|---|---|
| Insulated cavity wall | No | ** | Possible | * (see note) | £ |
| Internal lining | No | * | No | No | ££ |
| External insulation | *** | *** | Possible | *** | £££ |

* = not good  *** = good
£ = less expensive  £££ = more expensive
Note: some injection foam systems are designed to provide structural stability when wall ties have corroded

*Table 1 Comparison of different wall insulation methods in refurbishment projects*

## SELECTING EXTERNAL INSULATION SYSTEMS

Despite the relatively high installation costs, EI gives a high potential for cost savings together with the least disruption to residents. It is particularly appropriate where a high-rise structure presents thermal bridging problems, eg through an exposed concrete frame.

### EXTERNAL INSULATION FOR NEW BUILD DWELLINGS

EI is often the most logical solution for refurbishment projects, but is not as frequently considered for new build as it is in continental Europe and further afield.

There are many benefits to be gained for incorporating EI in new build construction, especially when cladding or render is being considered for the exterior finish.

Benefits for new build include the following.

- High levels of insulation can be incorporated without having to increase the size of the structure to achieve larger cavities or to compensate for the reduction in room sizes when using internal linings.
- It is possible to simplify wall construction and reduce construction costs by using solid load-bearing walls, since there is no need for a cavity.
- Simplified construction detailing avoids thermal bridging and air leakage, particularly around openings and at wall to floor junctions.
- The effect of thermal mass in the wall construction, floors and internal partitions is maximised. The ‘insulation blanket’ around the walls of the building contributes to levelling out internal temperature fluctuations.
- It can lead to faster construction where speed is an important factor in the building process.

As in refurbishment projects, the structure of the building is protected from the effects of weather and the temperature difference between the inside and outside of the building. With EI, the dew-point, or area where the vapour migrating from inside the building is likely to condense in the colder parts of the construction, is towards the outside and away from the critical structural or load-bearing wall elements.

### EXTERNAL INSULATION SYSTEMS AVAILABLE

The following generic systems are available to choose from:

- wet render systems
- dry cladding systems
- bespoke EI systems.

Wet render and dry cladding systems are often proprietary products, developed and tested with third-party accreditation (such as BBA or WIMLAS) for use in particular situations. They are normally guaranteed when installed by a system manufacturer’s approved contractor.

Bespoke systems are designed by architects or others for particular projects and combine all the elements of proprietary systems. They often incorporate dry cladding and should be specified in conjunction with appropriate experts, eg in timber technology.

Each generic system is explained in detail in the following pages with comparisons made to aid selection.

***Figure 2 Skywood House, Middlesex, by Foster and Partners***

Sto Limited

# SELECTING EXTERNAL INSULATION SYSTEMS

## ADVANTAGES OF EXTERNAL INSULATION

- Protects the fabric of the building.
- Improves thermal performance.
- Ensures consistent U-values.
- Reduces thermal bridging, minimising condensation and heat loss.
- Reduces thermal stress on the structure or substrate.
- Transfers the dew-point to outside the structural wall element.
- Improves airtightness of the construction, which reduces draughts and heat loss.
- Optimises use of thermal mass, reducing internal temperature fluctuations.
- May contribute to improved sound insulation as part of general refurbishment strategy, eg window replacement.
- Available in a wide range of external finishes.
- Is relatively easily installed, leading to faster construction.
- Gives ease of quality control as insulation coverage is clearly visible.
- Proprietary systems are often independently tested and certified for use in particular situations.
- When installed by an approved contractor, proprietary systems can be covered by a company guarantee.

### Advantages for refurbishment applications

- Gives major aesthetic improvements.
- Renews ageing exterior façades.
- Lowers maintenance costs.
- Limits disruption to the fabric of the building.
- Some systems can help strengthen the existing structure.
- Increases life expectancy of buildings.
- Increases the value of the property.
- Can help upgrade the property to a mortgageable standard.
- Avoids internal building works.
- Can be installed during occupancy.
- Does not reduce the size of rooms.
- Larger amounts of insulation can be added externally.
- Contributes to elimination of internal problems, such as damp, condensation and mould growth, when accompanied by controlled ventilation.

### Advantages for new build applications

- Simplifies construction, particularly when avoiding thermal bridging and achieving airtightness.
- Easily achieves high levels of insulation without increasing the size of the structure.
- Reduces labour and materials used, leading to a good value construction.
- Usually eliminates the need for a vapour barrier, as the dew-point is transferred to outside the structure.

## DRAWBACKS OF EXTERNAL INSULATION

- EI finishes are not as robust as solid construction; without attention, damage can lead to dampness and weathering problems.
- Critical detailing requires knowledgeable design and care during installation.
- Construction costs are perceived to be high compared to traditional construction in new build.
- Approved installers must be used for proprietary systems.
- Guarantees are only provided if a proprietary system is used, otherwise performance becomes the designer's liability.
- Small projects demand the same level of technical support from system manufacturers as larger projects, hence they are relatively more expensive.
- EI is not suitable where an existing substrate is structurally unsound or cannot be repaired.
- EI may not be suitable for listed or sensitive historic buildings.

# 3 WET RENDER SYSTEMS

There is a wide range of wet render systems on the market. As insulation and fixing components are common to most systems, the component that distinguishes a high-performance wet system from a low-performance wet system is the thickness and quality of the render.

Wet render systems consist of:

- insulant
- adhesive mortar and/or mechanical fixings, eg mushroom-headed dowels; fixing materials include polypropylene, nylon, stainless steel and plated steel
- profiles and edgings in galvanised steel, stainless steel, plastic or aluminium, used on corners, at damp-proof course (DPC) level, window reveals, verges and copings
- base-coat render, incorporating a glass fibre, plastic or metal mesh
- top-coat render with or without a finish.

Wet render systems are classified by the Insulated Render and Cladding Association (INCA) in the following way.

### TRADITIONAL RENDER (THICK RENDER)

- Two to three coat cementitious to BS 5262.
- Factory batched – may contain polymers.
- Total thickness – 16-25 mm over insulant.

### POLYMER MODIFIED CEMENTITIOUS RENDER (PMCR)

- Fibre-reinforced.
- Applied in one or two coats.
- Total thickness – 6-12 mm over insulant.
- Can have a polymeric top coat.

### POLYMERIC COATING (THIN RENDER)

- Polymer modified cementitious or cement-free base coat.
- Base coat – 4-6 mm over insulant.
- Synthetic textured finish – 1.5-4 mm.

### INSULATING RENDER

- Air-based insulant in a traditional (thick) render.
- Total thickness – 25-80 mm.
- Gives a relatively small increase in thermal performance.

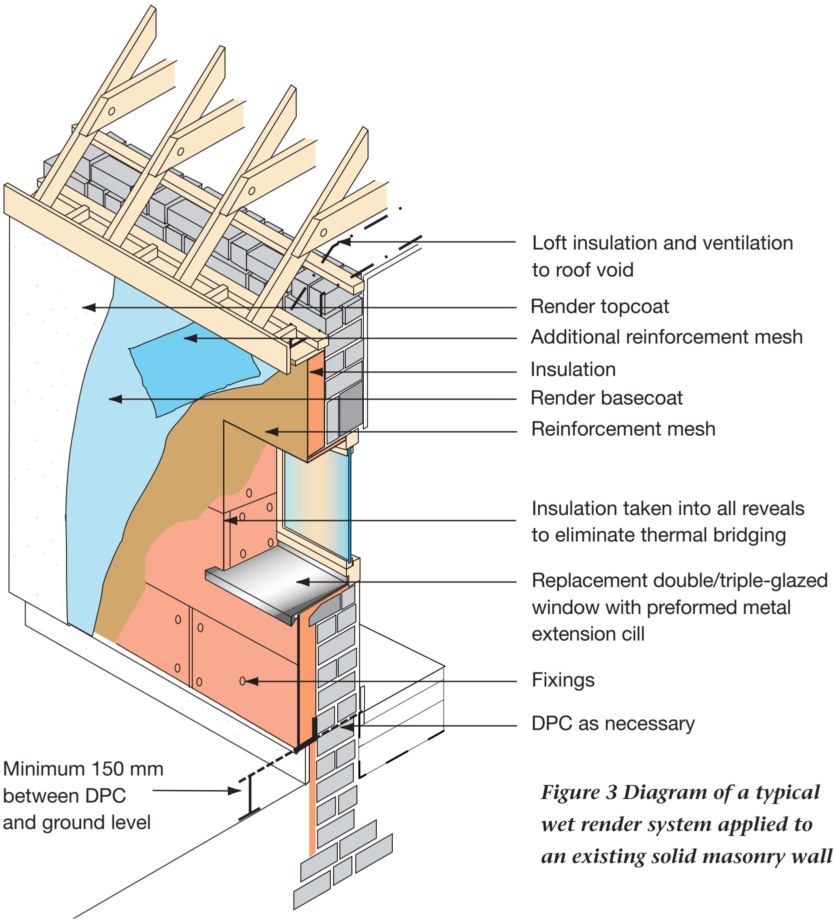


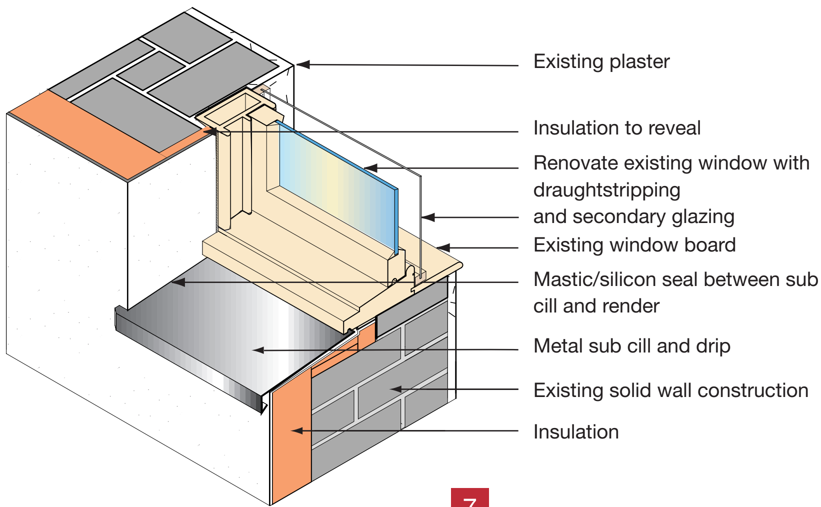

*Figure 3 Diagram of a typical wet render system applied to an existing solid masonry wall*

### USE OF WET RENDER SYSTEMS

Traditional render and PMCRs can be used on both low-rise and high-rise buildings. Polymer helps to make the render more workable on site, and in higher quantities provides weather protection and elastic flexibility in the render. PMCR render systems have been used in the UK for over 15 years.

Thin polymeric coatings can be used on both low-rise and high-rise buildings. The reduced weight of the render can be found to be advantageous in high-rise buildings. They do not need movement joints unless the building substrate has them. Polymeric coatings are relatively new to the UK market.

*Figure 4 Refurbishment window reveal detail*



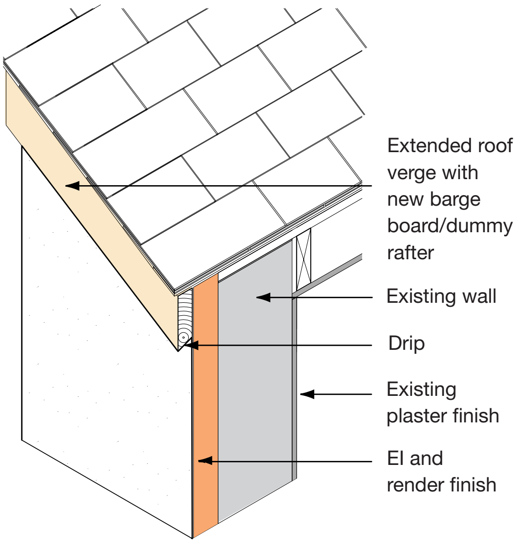
## 4 CRITICAL DETAILING – WET RENDER SYSTEMS

For wet systems, there are standard details and methods of application that must be followed according to manufacturers' recommendations. Particular care should be taken in the following areas.

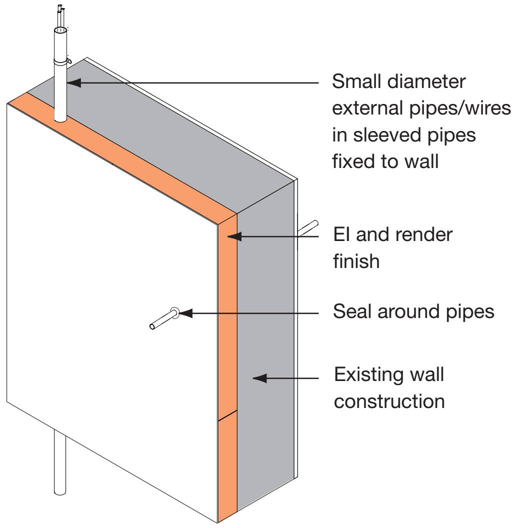
- Fire spread and fire barriers – all systems must meet the current standards and regulations. Note that in multi-storey buildings, unless mineral wool insulation is used, fire breaks will be required in the EI system to prevent the spread of flame externally.
- Fixings to the substrate – must take into account the nature and condition of the substrate, dead and imposed loads (wind pressure and dynamic suction), corrosion of fixings, and the movement of the system with, or isolated from, the building fabric.
- Thermal bridging – particular care with insulation detailing at window and door reveals, eaves, verge, ground details and fixing details to substrate, particularly in refurbishment projects (eg details around balconies, handrails and signs).
- Render specification – to ensure weather protection, resistance to cracking, durability, aesthetic requirements, resistance to dirt and algae and to fulfil maintenance requirements.
- Specification of PMCR – the quantity of polymer used may vary considerably and the specifier should seek assurance from the manufacturer that the render is suitable for a specific application.
- Racking of renders and differential movement – cementitious-based renders must have movement or expansion joints in accordance with manufacturers' recommendations. The provision and design of movement joints varies with each system and manufacturers' specifications must be used.
- Movement joints in the existing structure – EI will need joints at the same location.
- Day-work joints – should be specified in the render system.
- Work on site – precautions should be taken to minimise particle spread from rasping of polystyrene insulation as they are non-biodegradable and may present a hazard, causing annoyance to occupants and users of the area.
- Air leakage – must be prevented through the construction by correct detailing to avoid heat loss.
- Sealing of joints – must prevent water ingress into the system.
- Bi-metallic corrosion – must be avoided by correct specification.
- DPC detailing – in existing and new buildings must not be compromised by insulation cover. Refer to manufacturers' details.
- Existing and new services – designers and installers need to resolve how to treat, for example, down pipes, gutters, gas mains, phone lines and aerials.

## CRITICAL DETAILING – WET RENDER SYSTEMS

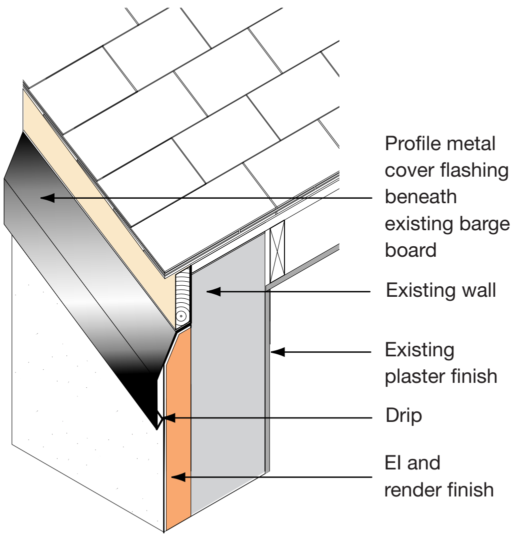
**Refurbishment verge detail**




**Refurbishment detail showing inclusion of services in EI system**




**Alternative refurbishment verge detail**




**Detail showing a fixing through EI system**

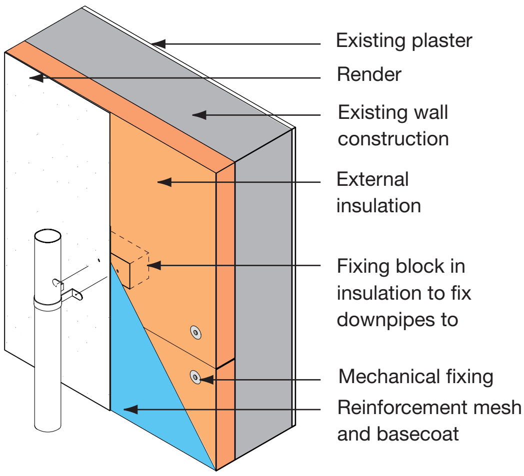



*Figure 5 Selected details for wet render systems*

# 5 DRY CLADDING SYSTEMS

Many dry cladding systems are available. They use a variety of supporting frameworks fixed back to the substrate or building structure. A cladding material is fixed to the framework based on standard cladding technology.

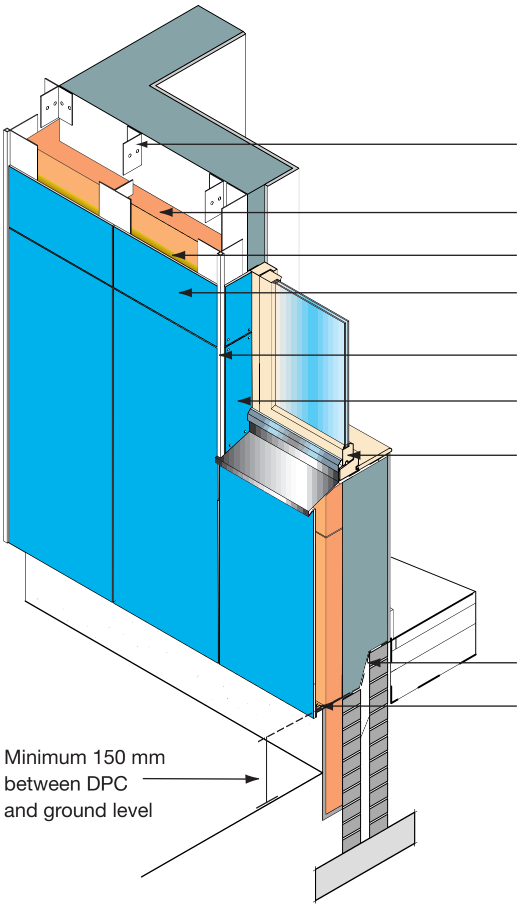
Dry cladding systems consist of:

- insulant fixed to the substrate in a similar way to wet systems
- supporting framework or cladding fixing system
- ventilated cavity
- cladding material and fixings.

### INSULANT

- Independently fixed to the substrate with a mechanical or adhesive fixing, or partially retained by the framework.
- Quilt material can reduce the risk of thermal bridging forming a tight fit around the framework.

*Figure 6 Diagram of a typical dry cladding system*




### SUPPORTING FRAMEWORK OR CLADDING FIXING SYSTEM

- Constructed of treated timber, steel or aluminium.
- An adjustable framework ensures a true plane can be achieved over an uneven substrate.
- A stand-off framework or cross-battening allows a continuous layer of insulation to the substrate, minimising thermal bridging.
- Spans over substrate areas where fixings cannot be obtained.
- Framework members, their size, frequency and strength of fixing to the substrate are designed to withstand wind-loadings in accordance with manufacturers' recommendations.
- Will accommodate the insulation and a ventilated cavity behind rainscreen cladding.

### VENTILATED CAVITY

- Most dry cladding systems incorporate a ventilation cavity between the cladding and the insulation to ensure that any moisture penetrating the cladding through the joints or migrating from inside the building is carried away.

### CLADDING MATERIALS AND FIXINGS

- Many cladding materials are available, including resin-impregnated laminates, highly compressed mineral wool, fibre-reinforced calcium silicate, aluminium panels and clay tiles.
- Can have open joints to form a rainscreen cladding, or sealed joints for a fully sealed system.
- A wide range of colours and textures are available.
- Cladding fixings include nails, screws, rivets or partial secret fixing using adhesives.
- Pressed profiles, trims and cover/edge retention strips can add to the decorative effect of a panellised cladding system.

### USE OF DRY CLADDING SYSTEM

Dry cladding is particularly useful where fixings are restricted to particular areas of the building. Access can be gained for periodical checks or maintenance work, as is often required with high-rise buildings.

Dry cladding is not used frequently on low-rise dwellings where the cost can be prohibitive.

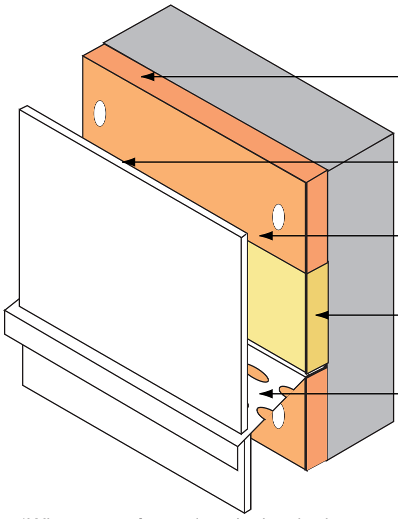
# 6 CRITICAL DETAILING – DRY CLADDING SYSTEMS

As for wet systems, methods of application and system detailing should be according to manufacturers' recommendations. Particular care should be taken in the following areas.

- Fire spread and fire barriers – all systems must meet current standards and regulations. Fire protection measures include provision of a strip of non-combustible insulation, introduction of a cavity barrier and prevention of surface spread of flame.
- Fixings to the substrate – must take into account the nature and condition of the substrate, dead and imposed loads (wind pressure and dynamic suction), movement of system with or isolated from the building.
- Thermal bridging – prevention by the use of a stand-off framework or cross-battening and ensuring the insulation is fitted tightly around the framework.
- Maintenance of ventilation behind rainscreen cladding – by correct configuration of the supporting framework, correct fixing and retention of the insulation material and provision of permanent ventilation gaps above and below the cladding, window openings and non-perforated cavity barriers. Bird and insect barrier or mesh should be added.
- Air leakage – must be prevented through the construction by correct detailing to avoid heat loss.
- Bi-metallic corrosion – must be avoided by correct specification.
- Compatibility of boards and metal support frameworks may mean using an isolating material foam tape.
- Movement – an allowance for movement is made at all cladding joints in accordance with manufacturers' details.
- DPC detailing in existing and new buildings must not be compromised by insulation cover.
- Existing and new services – designers and installers need to resolve how to treat down pipes, pipes, gutters, gas mains, phone lines and aerials.
- Concealed fixings – metal cladding panels can be formed with a hook-on to provide total secret fixing.

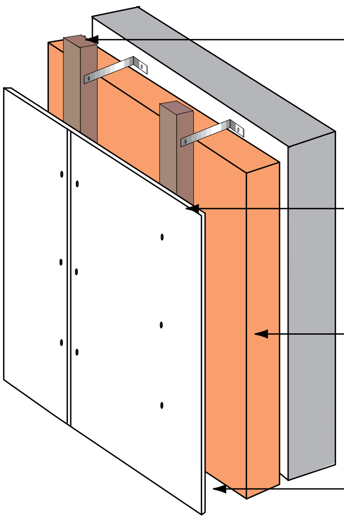
*Figure 7 Selected details for dry cladding systems*

**Cavity fire barrier detail**

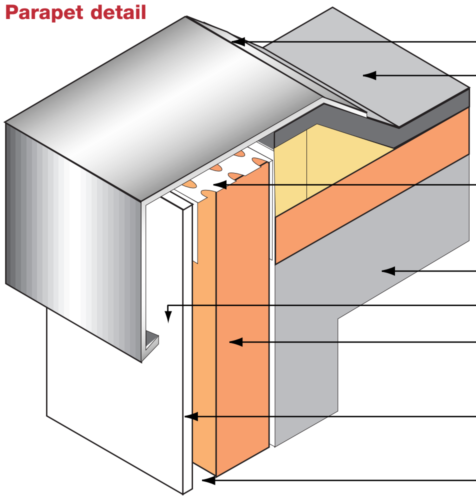



**Where a perforated cavity barrier is not used, a ventilation gap must be maintained in the cladding above and below the barrier*

**Dry cladding detail to avoid thermal bridging**




**Parapet detail**



# 7 BESPOKE EXTERNAL INSULATION SYSTEMS

Clive Boursnell

*Figure 8 Built example using unseasoned oak cladding, by Gale and Snowden Architects*

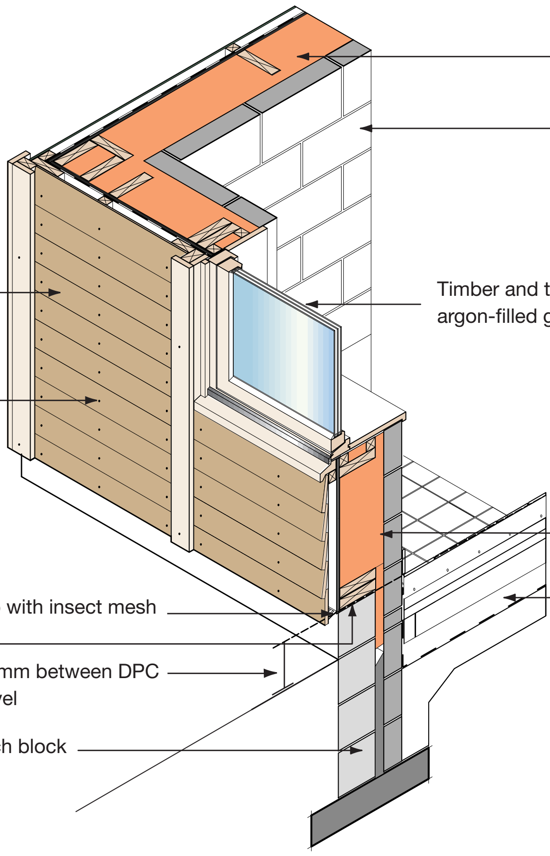



*Figure 9 Diagram of a new build bespoke EI system, Gale and Snowden Architects*

## BESPOKE EI DESIGN

Designed individually by architects and designers, such a system tends to be simply detailed, allowing a non-specialist building contractor to construct it.

The potential for bespoke EI design mainly lies in dry cladding. A typical design may incorporate a rainscreen onto a substrate such as single blockwork, employing simple timber framing technology.

It should be noted that a guarantee will not normally be available and reliance will most likely be placed on the designer's professional indemnity insurance.

Figure 8 shows the use of unseasoned oak weatherboard as an external cladding.

## CRITICAL DETAILING AND WATCHPOINTS FOR BESPOKE EI SYSTEMS

As for dry cladding systems, the design should consider:

- water ingress – maintain a ventilated cavity
- dynamic suction and imposed loads
- fire protection – incorporate cavity barriers and prevent surface spread of flame
- maintenance and durability – suitable specification of cladding material and ease of replacement.

## AN EXAMPLE OF A BESPOKE EI DESIGN

Figure 9 shows the use of blockwork internally giving thermal mass. Timber studwork and a sheathing material forms a 250 mm cavity filled with loose cellulose insulation.

Where solid timber studwork is used, it is bracketed off the blockwork to avoid thermal bridging. Alternatively, lightweight composite I-beams of low thermal conductivity can be used. The whole construction is vapour permeable.

A ventilated cavity and unseasoned oak weatherboarding act as a rainscreen. This architect-designed system demonstrates how insulation can be incorporated externally and that it is possible to use environmentally sustainable materials.

# 8 ENVIRONMENTAL CRITERIA

## INSULATION THICKNESS AND SUSTAINABILITY

In broad terms, the cost of systems lies mostly in the external cladding or render, and so it is logical to maximise the amount of insulation thickness to maximise the benefits gained.

Figure 10 shows how the payback (when capital cost is offset by the savings made) for external insulation (based on expanded polystyrene) is affected by heating system type and insulation thickness. Notice that it is not worth considering thin insulation since the payback is long. Instead, it is generally worth installing as much as possible since the payback curve becomes relatively flat, ie the extra cost of the insulation is balanced by the extra savings.

The limit of insulation thickness on refurbishment projects is set by difficult details, such as moving guttering and extending eaves or verges. However, for 'good practice', the minimum thickness of insulation should be at least 100 mm.

## ENVIRONMENTAL EFFECTS OF SYSTEM MANUFACTURE AND INSTALLATION

The main issues affecting the sustainability of EI systems are the impacts from:

- embodied energy use
- mineral extraction
- use of ozone-depleting chemicals.

### Embodied energy use

Embodied energy use is dependent on the mass of material used per $m^2$ and the embodied energy of the material. Materials such as polymers, metals, plastics and foams are comparatively high in embodied energy, while traditional render materials and timber are low in embodied energy. The embodied energy of external insulation is generally paid back by energy savings in under 10 years (provided a reasonable thickness of insulation has been installed). In all cases, this is considerably less than the estimated life of the systems themselves.

### Mineral extraction

Quarrying can cause local disturbance from noise and dust, and destruction of habitat. The production of metals also requires the extraction of large amounts of ore, resulting in corresponding amounts of waste.

### Ozone depletion

Many insulating foams use blowing agents, such as HCFCs, which cause ozone depletion. Compliance is most easily obtained by asking if the manufacturer will certify the material as having zero ozone-depletion potential (ZODP). In the classification overleaf the assumption has been made that these insulants are not being used at all – if they are, the summary rating drops down to a 'C'.

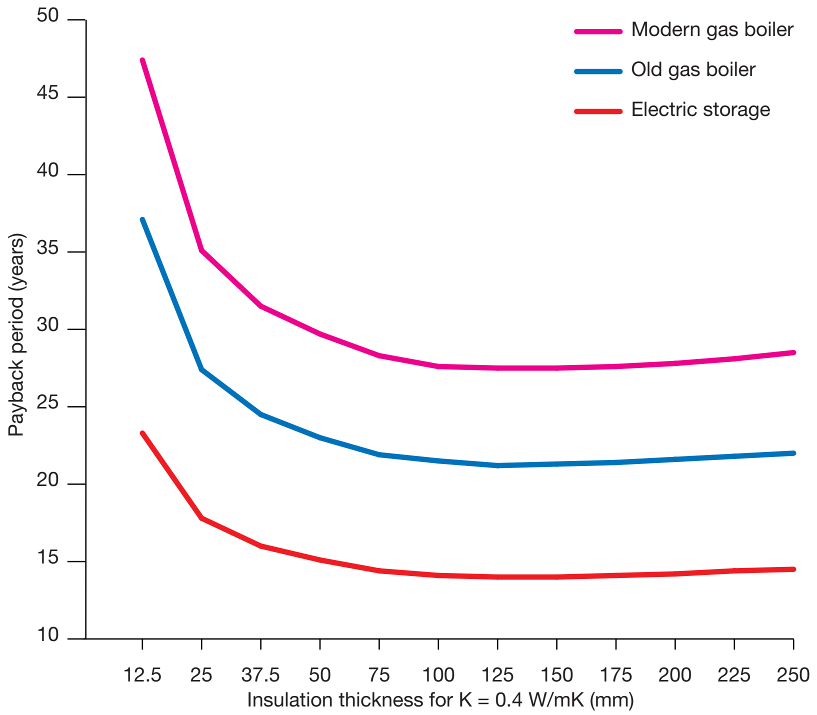



***Figure 10 Payback period graph for insulation thickness***

*The heating system, in particular the fuel cost and the efficiency of the system, does have a significant effect – the more expensive the fuel, the shorter the payback time. There is also an advantage in that undersized heating systems become more acceptable. The payback is not significantly affected by the type of building, provided it is heated to a reasonable standard.*

## ENVIRONMENTAL CRITERIA

| Element type | Element | Insulation groups A B C | Summary rating | Climate change | Fossil fuel depletion | Ozone depletion | Freight transport | Human toxicity | Waste disposal | Water extraction | Acid deposition | Ecotoxicity | Eutrophication | Summer smog | Minerals extraction | Typical replacement interval | Recycled input | Recyclability | Recycled currently | Recycling energy |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| **Bespoke timber clad** | Local timber cladding, timber framework | any – A B or C | A | A | A | A | A | A | A | A | A | A | A | C | A | 30 | C | A | B | A |
| **Dry cladding systems** | Aluminium/plastic board, aluminium framework | any – A B or C | B | B | A | A | A | C | A | B | A | A | A | A | A | 40 | A | B | A | B |
| | Aluminium/plastic board, steel framework | A rating | A | A | A | A | A | B | A | A | A | A | A | A | A | 40 | B | B | A | B |
| | | B or C rating | B | B | B | B | A | C | A | A | B | B | B | A | A | 40 | B | B | A | B |
| | Epoxy resin laminate board, aluminium framework | any – A B or C | C | C | C | A | A | B | B | B | C | A | A | C | A | 30 | C | C | B | C |
| | Fibre cement board, aluminium framework | A or B rating | A | A | A | A | A | B | A | C | A | A | A | A | A | 40 | A | B | A | A |
| | | C rating | B | B | B | A | A | B | A | C | B | A | A | A | A | 40 | A | A | A | A |
| | Terracotta rainscreen cladding, aluminium framework | A rating | A | A | A | A | A | B | A | B | A | A | A | A | A | 30 | A | B | A | B |
| | | B or C rating | B | B | A | C | A | C | A | B | A | B | C | A | A | 30 | B | B | A | B |
| **Insulating render** | Insulating lime render | n/a | C | B | B | A | C | A | C | A | A | A | A | A | C | 30 | C | A | A | A |
| **Polymer-modified cementitious render** | Polymer-modified cementitious render, glass wool mesh | A or B rating | A | A | A | A | A | A | B | B | A | A | A | A | B | 25 | C | A | A | A |
| | | C rating | B | B | B | A | A | A | A | B | B | A | A | A | B | 25 | C | A | A | A |
| **Polymeric coating** | Polymeric coating, glass wool mesh | A rating | B | B | B | A | A | B | A | A | B | A | A | B | A | 20 | C | C | C | C |
| | | B or C rating | C | B | C | C | A | C | A | A | B | C | C | A | A | 20 | C | C | C | C |
| **Traditional render** | Sand/cement render, glass wool mesh | any – A B or C | A | A | A | A | A | A | B | C | A | A | A | A | C | 30 | C | A | A | A |

*Table 2 Environmental rating for different EI systems*

This table shows the (A, B, C) environmental rating for different external insulation systems. Ratings are awarded against the issues described above as A, B or C, indicating the best third, middle, or worst third of the list of systems examined. This data is reproduced by courtesy of the BRE's Centre for Sustainable Construction. The information is part of the Green Guide to Housing Specification (BR 390) available from CRC Ltd (see further reading on the back cover for details).

**Group A** Expanded polystyrene, glass wool, mineral wool, recycled cellulose
**Group B** Corkboard, foamed glass, polyurethane (ZODP)
**Group C** Extruded polystyrene (ZODP)
*Any use of insulation that does not have ZODP rating will automatically receive a 'C' summary rating.*

**The issues rated in table 2 are briefly defined as follows.**

| | |
|---|---|
| **Climate change** | Global warming gases |
| **Fossil fuel depletion** | Coal, oil and gas consumption |
| **Ozone depletion** | Gases which destroy the ozone layer |
| **Freight transport** | Distance and mass of freight moved |
| **Human toxicity** | Pollutants which are toxic to humans |
| **Waste disposal** | Material sent to landfill or incineration |
| **Water extraction** | Mains, surface and ground water consumption |
| **Acid deposition** | Gases which cause acid rain, etc |
| **Ecotoxicity** | Pollutants which are toxic to the ecosystem |
| **Eutrophication** | Water pollutants which promote algal blooms, etc |
| **Summer smog** | Air pollutants which cause respiratory problems |
| **Minerals extraction** | Metal ores, minerals and aggregates mined |

# 9 SELECTING A SYSTEM

## FACTORS AFFECTING THE CHOICE OF SYSTEM

- Suitability for the proposed application – proprietary systems should be tested and accredited by a third party for use in a particular situation.
- Suitability for location – according to exposure ratings in BS 8104, 'Code of practice for assessing exposure of walls to wind-driven rain'.
- Resistance to wind-loading – the design and type of the fixings and strength of the system.
- Condition of the substrate – the type of fixing or framework that is available.
- Performance of the insulation – thickness of insulation to be achieved.
- Quality and range of finishes, textures and colours – to suit the aesthetics of the scheme.
- Mouldability and flexibility of system – to form or fit around external features on a façade.
- Fire performance – incorporation of fire barriers and prevention of fire spread.
- Vapour permeability – to ensure the correct dew-point position in the construction.
- Availability of a company guarantee – offered by manufacturers when installed by an approved contractor.
- Quality assurance – manufacturers and installers may be BSI registered under ISO 9001 or 9002 for the design, manufacture and supply of their systems.
- Buildability and ease of construction – to avoid problems on site.
- Speed of construction – for a cost-effective solution.
- Cost of supply and installation – affected by ease of access.
- Maintenance requirements – to ensure longevity and low long-term costs.

## FACTORS AFFECTING THE CHOICE OF INSULANT

- Nature or form of insulant, its rigidity and workability, eg a panel, quilt or loose beads/fibres.
- Mouldability and flexibility of material to form or fit around external features.
- Degree of support required for the render or finish.
- Performance in fire.
- Chemical composition – CFC/HCFC free and ZODP.
- Embodied energy content.
- Cost.

## FACTORS AFFECTING THE DETAILING OF A SYSTEM

- Strength of system for dead and imposed loads.
- Wind loading and resistance to suction.
- Nature of the substrate or structure – its strength, soundness and friability.
- Long-term performance of the finish.
- Thermal shock – differential movement between render and insulation due to rapid temperature differences.
- Freeze/thaw cycling.
- Heat and moisture cycling.
- Capillary water action.
- Corrosion of fixings and trims.
- Impact resistance.
- Fire spread and the incorporation of horizontal and vertical fire barriers, use of appropriate fixings to prevent deformation of cladding during fire.
- Vapour permeability and interstitial condensation.
- Dimensional variation as a function of temperature and humidity.
- Differential movement between materials – eg controlling the amount of metal components in render.
- Long-term maintenance care.

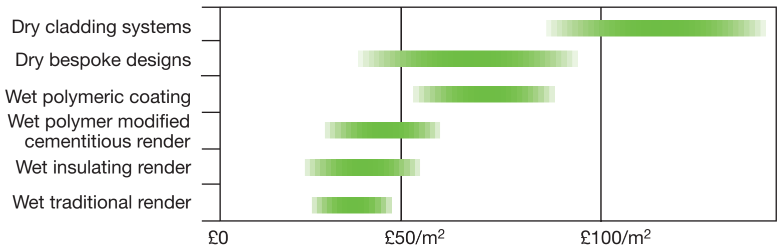



***Figure 11 Comparison of cost for EI systems***

*Note: the costs shown are approximate. Costs of external insulation are strongly dependant upon the location and height of the project (access costs), contract size, and complexity of detailing.*

## SELECTING A SYSTEM

| | Advantages | Drawbacks |
|---|---|---|
| **Wet render systems** | ■ Different systems are available in a range of technical performances for varying situations.<br>■ Polymeric coatings (see page 7 for a description) do not need movement joints where they are not required in a substrate.<br>■ Manufacturers' technical service is available. | ■ Renders cannot be applied in low temperatures, especially polymeric coatings.<br>■ It is not possible to inspect behind render after application without remedial works.<br>■ Mess on site may occur when rasping polystyrene.<br>■ High quality control required on site.<br>■ No agreed standards on polymer quality and content for PMCR (although they must meet third-party testing criteria). |
| **Dry cladding systems** | ■ Panels can be removed easily for inspection or for replacing.<br>■ A dry system with a ventilated cavity may be more appropriate where driving rain and high exposure levels are a problem.<br>■ Vapour permeability is maintained where a ventilated cavity is used.<br>■ Fixing system or framework can provide some degree of stability or span over problem areas.<br>■ Faster construction than wet systems.<br>■ Can be applied in freezing conditions.<br>■ Manufacturers' technical service is available. | ■ High-performance dry systems can be relatively expensive compared with high-performance wet render systems.<br>■ Thermal bridging may arise unless carefully designed out.<br>■ Supervision is required for correct installation of insulation to ensure reduction in thermal bridging and maintenance of ventilated cavity.<br>■ High quality control required on site. |
| **Bespoke EI** | ■ Gives control of the composition and costs of individual materials as they are not part of a manufacturer's package.<br>■ Gives the opportunity to use sustainably sourced products and materials.<br>■ Gives the ability to design the system to allow vapour permeability through the wall construction.<br>■ A wider variety of finishes can be used – eg weather boarding, stone, glass, terracotta and tile hanging.<br>■ Is of tailor-made design to suit the building and its context. | ■ No guarantees are available.<br>■ No technical service is available from system manufacturers.<br>■ Guaranteed performance becomes designer's liability.<br>■ New designs are untested. |

*Table 3 Comparison of different EI systems*

### DURABILITY AND MAINTENANCE

External insulation is vulnerable to damage, particularly at ground floor level, therefore:

- either avoid or strengthen EI in areas where damage may occur
- provide additional strengthening reinforcement for wet render systems at vulnerable areas, such as at ground floor level, around entrances or near vehicular access
- for dry systems, select toughened panels and stronger fixings at vulnerable areas
- discourage graffiti by the use of texture and colour or a finish which can be safely over-painted.

Most wet render systems can be used in severe weather conditions. Care should be taken when selecting systems for these situations and evidence of test results or a proven track record should be assessed.

Maintenance of EI is dependent on the external finish or cladding used. Dry systems with smoother surfaces tend to need less maintenance than wet systems. The frequency of maintenance also depends on the location and quality of appearance required. North walls or walls with reduced wind turbulence, eg adjacent to other

## SELECTING A SYSTEM

buildings, may suffer from increased levels of algal growth and effects of pollution. External flues and fans will also cause a localised build-up of dirt.

Maintenance of wet render systems can vary from low to periodic over-coating with an acrylic or silicone paint finish. Often the only degrading is of the finish itself. It can develop a dirty or stained appearance which, if aesthetically unacceptable, will require maintenance. Some manufacturers recommend periodic pressure washing at 5-10 year intervals.

### KEY REMINDERS

- Systems must be designed and constructed to conform to all current standards and regulations relating to fire.
- A proprietary system should have third party accreditation and the certificate should detail the specific application which is proposed.
- Contractors should be approved and trained by the chosen proprietary system manufacturer. They should have an appropriate quality assurance scheme and be members of the trade association.
- Ensure there is an appropriate insurance-backed guarantee available for the installed proprietary system.
- Keep to simple designs for external façades, since EI lends itself to expensive and repetitive construction.
- Conduct site checks of workmanship in wet systems, that corner and edge details are straight.
- Conduct site checks of workmanship in dry systems, that insulation is installed correctly around frameworks without thermal bridging and that the ventilated cavity behind the rainscreen is not bridged.
- Avoid excessive hot and cold temperatures when applying wet renders which can cause drying/curing problems on site. Polymeric coatings are particularly susceptible to application at low temperatures, as they may not coalesce (adhere together or 'film form').
- Consider a dry system with a ventilated cavity where exposure to driving rain may be a problem.
- Do not use EI (dry or wet) in vulnerable areas since it is prone to damage. Alternatively, provide additional protection.
- Ensure adequate technical input is available for proprietary systems. Agree all details with system designers or specialists in advance of work on site.
- Establish who carries the design liability for system performance before specification.
- Expect more maintenance than manufacturers suggest for both wet and dry systems and inspect previous applications. Note that all wet renders are prone to cracking, so establish what is an acceptable level of cracking for your project.
- Do not apply EI to an existing structure that is unsound.
- Take care with periodic over-coating to ensure that additional paint layers do not compromise fire properties or vapour permeability.

# 10 EXAMPLES OF WET RENDER SYSTEMS

Gale & Snowden

Figure 12 Example of a refurbished high-rise building – Moorfield, by Bristol City Council

## REFURBISHMENT – WET SYSTEMS

Wet EI systems are often used in the refurbishment of existing properties. The application is most effective when incorporated as part of an overall strategy to improve the energy efficiency, appearance and comfort levels of a building. Wet systems appropriate for high-rise properties include those with both thick and thin renders.

Where EI is vulnerable to impact damage, such as on the ground floor façade, it can be strengthened by including additional reinforcement mesh or rigid panels. However, many built examples avoid using EI in these vulnerable areas and instead use different insulation methods.

### High rise

This typical tower-block refurbishment project using a polymeric coating provided a high-performance, low-maintenance finish. It incorporates 100-150 mm of polystyrene insulation with mineral wool fire breaks. The renovation package included new double-glazed windows and doors and converted external balconies into internal spaces. There are other associated benefits – the previously under-sized heating system is now adequate and the problem of traffic noise has been reduced.

Gale & Snowden

Figure 13 (right) Example of a refurbished low-rise building – BISF housing, by Rugby City Council

### Low rise

This example of upgraded British Iron and Steel Federation (BISF) housing uses a thick polymer modified cementitious render, incorporating 50-80 mm of insulation. A render finish is used at the first floor and a rendered brick look-alike finish at ground floor. Additional features, such as new porches, were fixed through the insulation system.

INCA

## NEW BUILD – WET SYSTEMS

EI can often simplify and speed construction in new build. Higher levels of insulation can be more easily achieved compared with traditional forms of construction.

The following examples illustrate the use of wet render systems using polymeric coatings.

### High rise

These luxury apartments have 100 mm of mineral wool insulation fixed to a solid concrete wall construction. The PMCR with polymeric render coating was used to achieve a finish without movement joints and for high performance in exposed conditions.

Figure 14 Example of a new build high-rise building – Vogans Mill, London, by Michael Squires Associates

### Low rise

A polymeric render coating was used for this architect-designed house mainly for aesthetic reasons. The external render system continues the line of the internal render, over the edges of the wall to form the coping detail, sharp angle/corner details and is allowed to ‘disappear’ into the ground, giving the wall a monolithic appearance.

Figure 15 Example of a new build low-rise building – Crescent House, Wiltshire, by Foster and Partners

Nigel Young

# 11 EXAMPLES OF DRY CLADDING SYSTEMS

## REFURBISHMENT – DRY SYSTEMS

Dry cladding systems are predominantly used in the UK commercial building sector. In residential buildings, they are used for refurbishment projects, but tend not to be used for new build.

Gale & Snowden

*Figure 16 Example of a refurbished high-rise building – Woolwich, London, by Hunt Thompson Associates*

### High rise

This example of a multi-storey refurbishment project uses a high-performance dry cladding system. It was chosen for the following reasons:

- it allowed removal of the cladding panels for periodical inspection of the building structure
- a high-quality cladding system was appropriate for the severe weather rating
- a ventilated cavity behind the rainscreen allowed the building to breathe and moisture to be carried away
- high speed of erection was achieved.

The ground and first floor external walls are of cavity brick construction to provide impact protection in vulnerable areas.

### Low rise

This example of dry cladding refurbishment achieved a renovated external envelope and added protection to the existing structure.Payback periods can be greatly reduced by introducing significant amounts of insulation which produces savings through energy efficiency.

Eternit

*Figure 17 Example of a refurbished low-rise building*

## OTHER PROJECTS

The following examples illustrate the use of EI in an architect's bespoke design and in a wet render system for an historically sensitive location.

### Bespoke EI system

This example of an architect-designed system consists of an internal blockwork wall with timber battens and mineral wool insulation fixed to its outer face. A ventilated cavity and timber weather-boarding provides a rainscreen. The system was not used on the ground floor, which was constructed of rendered blockwork cavity construction to withstand impact damage. Such systems require careful design to ensure that vapour permeability through the construction is not problematic. This should be checked by dew-point calculations.

*Figure 18 Example of a new build bespoke system – Barnstaple, Devon, by Clive Jones & Associates*

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### EI systems for listed buildings and conservation areas

Care should to be taken when specifying EI for historically sensitive buildings. The local authority should be consulted at the earliest opportunity in all cases. Certain wet render systems are appropriate for this situation, such as that used on the adjacent example of a listed building. A combination of recycled mineral material and polystyrene was used to form complex mouldings to replicate the original building features, such as the rustication and the cornicing, which had deteriorated beyond repair.

*Figure 19 Example of a refurbished listed building – Stanhope Gardens, London, by Chassay + Last Architects*

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# 12 BENEFITS OF WIDER USAGE AND FURTHER INFORMATION

## BENEFITS OF WIDER USAGE OF EXTERNAL INSULATION

- Reduce global $CO_2$ production through increased energy efficiency of buildings.
- Reduce resource use through effective re-use of old buildings.
- Reduce resource use in new build as EI systems use less resources than some traditional building construction.
- Improve building performance, with many beneficial knock-on effects, such as avoiding renewal of under-sized heating systems (due to increased thermal performance of the building) and by covering walls in poor condition to increase airtightness and reduce heat loss.
- Improve health of occupants, with raised comfort levels in old buildings, and by improving living conditions.
- Increase social benefits by enhancing the local environment and raising community pride.
- Discourage vandalism and help encourage community responsibility.

## GLOSSARY

| | |
|---|---|
| BBA | British Board of Agrément |
| BISF | British Iron and Steel Federation |
| BRE | Building Research Establishment |
| EI | External insulation |
| GRP | Glass-reinforced plastic |
| GRC | Glass-reinforced cement |
| INCA | Insulated Render & Cladding Association |
| PMCR | Polymer-modified cementitious render |
| WIMLAS Ltd | Independent assessors for the European building and construction industry |

## FURTHER INFORMATION

### Insulated Render & Cladding Association (INCA)

INCA is the industry trade association offering specifiers technical advice related to:

- the process of insulated render and cladding
- the selection of a system proven under UK climatic conditions
- matching a vetted contractor (generally with at least two years experience) to a project.

INCA also provides a 10-year insurance guarantee scheme for refurbishment and new build of all building types, with a further 10-year renewal option on expiry. The scheme covers design, material and workmanship, and is only offered through participating INCA installers where BBA or WIMLAS Certified INCA systems are applied. Contact INCA for a leaflet.

INCA, PO Box 12, Haslemere
Surrey GU27 3AH
Tel 01428 654011
Fax 01428 651401

## FURTHER READING

### BRE

Available from CRC, 151 Rosebery Avenue
London EC1R 4GB
Tel 020 7505 6622

- BR 390. The Green Guide to Housing Specification

### British Standards Institution

389 Chiswick High Road, London W4 4AL
Tel 020 8996 9001. Fax 020 8996 7001

- BS 8104. Code of practice for assessing exposure of walls to wind-driven rain
- BS 5262. Code of practice for external renderings

**Energy Efficiency Best Practice in Housing**

Tel: 0845 120 7799
www.est.org.uk/bestpractice

Energy Efficiency Best Practice in Housing is managed by the Energy Saving Trust on behalf of the Government. The technical information was produced by BRE.